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ABSTRACT

Many new technologies are now available for delivering and/or providing access to computer-based learning (CBL) materials. These technologies vary in sophistication in many important ways, depending upon the bandwidth that they provide, the interactivity that they offer and the types of end-user connectivity that they support.Invariably, appropriate combinations of the available technologies are needed in order to produce the most effective and efficient learning environment for any given application. Bearing this in mind, it is important to consider how multimedia resources, interactivity and global connectivity can best be used in order to produce a software product that best fulfills the requirements identified in any given courseware requirements specification. This paper discusses the types of models that are needed to create effective interactive, multimedia courseware. It also indicates the nature of the interactions that exist between these models and the ways in which these can be used to optimize the trade-offs that are inherent in the creation of multimedia CBL materials. (Author)

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Models and Methodologies for Multimedia Courseware Production

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Abstract: Many new technologies are now available for delivering and/or providing access to computer-based learning (CBL) materials. These technologies vary in sophistication in many important ways - depending upon the bandwidth that they provide, the interactivity that they offer and the types of end-user connectivity that they support. Invariably, appropriate combinations of the available technologies are needed in order to produce the most effective and efficient learning environment for any given application. Bearing this in mind, it is important to consider how multimedia resources, interactivity and global connectivity can best be used in order to produce a software product that best fulfils the requirements identified in any given courseware requirements specification. In this paper we discuss the types of model that are needed to create effective interactive, multimedia courseware. We also indicate the nature of the interactions that exist between these models and the ways in which these can be used to optimise the trade-offs that are inherent in the creation of multimedia CBL materials.

Introduction

Multimedia computing technology has opened up many interesting opportunities for the creation of new types of learning and training products covering a wide range of subject areas for many different audiences (Barker, 1996; 1999). Examples of the types of product include: electronic books; educational games; interactive products based on the use of compact disk (CD) technology; intranet and World Wide Web pages; and tools to facilitate 'electronic' knowledge sharing. Together, products of this sort can be used to enrich the scope and quality of computer-based learning (CBL) experiences.

Within the remainder of this paper we shall use the term '*interactive multimedia courseware*' to refer to computer-based learning products in which some skill or knowledge is intentionally transferred to a user of that product as a consequence of its use. Such software can be defined in terms of 'learning products' in which optimal combinations of text, sound and images are used to achieve particular learning outcomes using interactivity in various ways to achieve these objectives. Typically, interactivity is used: to facilitate navigation through the corpus of materials that make up the product; to provide assessment and feedback mechanisms; and to facilitate communication between the group of users that constitute the 'learning community' at which the product is focused.

When designing courseware, it is important to consider how multimedia resources, interactivity and global connectivity can best be used in order to produce a software product that successfully fulfils the conditions identified in any given courseware requirements specification. Because of the complex nature of both software development and the cognitive processes that take place during learning, this is no easy task. The design and development processes therefore need to be guided by appropriate models that encapsulate 'best practice' with respect to both system design and implementation issues. Relevant pedagogic models also need to be employed in order to ensure that the subsequent learning processes are relevant to the knowledge and skills that are to be acquired. Therefore, in this paper we shall discuss the types of model that are needed in order to create effective interactive, multimedia courseware. We also indicate the nature

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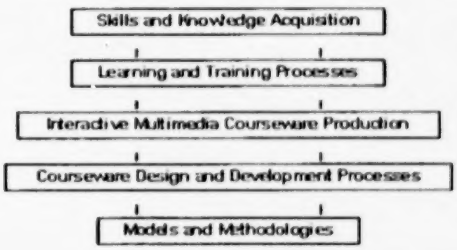
of the interactions that exist between these models and the ways in which these can be used to optimise the trade-offs that are inherent in the creation of multimedia CBL materials.

Underlying Models and Methodologies

There are two basic approaches to developing courseware products; we shall refer to these as the '*empirical approach*' and the '*theoretical approach*'. The first of these uses a strategy that is based essentially on a 'trial and error' procedure, that is, a learning product is produced and its effectiveness is determined; if necessary, an iterative 'fine-tuning' mechanism is then used in order to improve it. In the second approach, appropriate theories and models are used, in so far as they exist, in order to create a learning product that falls directly within a given 'region of acceptability'. This latter approach is attractive because it reduces the amount of uncertainty involved in product creation. It is our opinion that design and development models (and methodologies derived from them) should play a fundamental underlying role in guiding the production of interactive multimedia courseware. The underlying importance of these basic tools is reflected schematically in Figure 1.


Skills and Knowledge Acquisition
Learning and Training Processes
Interactive Multimedia Courseware Production
Courseware Design and Development Processes
Models and Methodologies

. These range from simple models, such as the 'waterfall' model to more advanced models and methodologies including: the CASE approach, SSADM, the spiral model, Siegal's approach, December's methodology, Dinucci's method, and so on. However, these models and methodologies are mostly used in the development and implementation of business-oriented information systems and are not normally suitable for the development of multimedia learning products.

Designing and developing multimedia learning products necessitates close co-operation between people with specific skills and expertise. Furthermore, the existence of diverse modes of storage and delivery necessitate the adoption of appropriate methodologies and suitable design models in order to create high quality learning products. In the remainder of this paper we shall discuss some of the more important issues relating to the formulation of the various models and methodologies that we feel are needed in order to underpin the successful development of interactive multimedia courseware products.

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Problems Arising in Multimedia Development

The development of interactive learning products usually requires a team of skilled specialists. Whilst many of these teams adopt their own approaches to the analysis, design and development of their products, there are no generally accepted models and methodologies specifically designed to assist in the creation of multimedia learning products. As the complexity of the products and the size of the development teams increase, it becomes more difficult to manage the production process efficiently. Most existing models and methodologies stress the importance of operation, providing information, handling events, and so on. However, these elements are not so important in courseware development, where the process involves the integration of all the available resources into a single piece of software. In this situation, the emphasis is on how to present a topic to users in a way that increases their knowledge and/or skills.

A multimedia project is normally composed of four equally important components: planning and design; resource and program development; testing and evaluation; and dissemination. Ideally, if we had adequate models, it would be possible to predict exactly how much time should be spent on each of the four phases. Invariably, the time spent on each individual phase is not equal and is often not predictable. In reality, many multimedia projects spend a much greater proportion of time on resource and program development and relatively little time on planning and design, testing and quality control, and dissemination and evaluation. Neglecting these major elements of the project life cycle could ultimately lead to a deficient product.

Of course, there are many other reasons why multimedia projects fail. For example, in a survey of the members of one multimedia development team, the three main factors contributing to unsuccessful projects were identified as: poor design; ineffective project co-ordination; and inefficient communication channels. Undoubtedly, most of these arise due to lack of a structured approach. In the following section of the paper we introduce a comprehensive methodology that is designed to improve the efficiency and effectiveness of multimedia development teams.

A Methodology for Creating Multimedia Learning Products

There are several good arguments in favour of adopting a sound methodology for developing multimedia learning projects. These include the necessity for good communication; consistency; effective quality control strategies; and accurate cost estimation. Some of the important issues that need to be addressed are outlined below.

Project Planning: the scope of a project, its budget and its intended completion date are usually negotiated prior to the commencement of any development activity. Once a project is formally agreed upon, management strategies are identified, milestones are established and tasks and resources (including individual team members) are identified.

Team Management: effective team management helps to establish a productive working atmosphere, deals with problems more readily and shares the workload efficiently. Figure 2 shows the structure of a typical multimedia development team in which the courseware designer and project manager co-ordinate the planning, design, development and testing. A clear definition of the roles and responsibilities of each team member ensures that all project tasks are allocated and allows contingency plans to be put in place in the event of any member of the team becoming unavailable.

Project Life Cycle: Figure 3 shows the four main phases involved in a typical multimedia project. The first three of these (preparation, design and development) are iterative processes. The fourth phase (dissemination) can be repeated if the product is revised or modified between releases.

Analysis of Requirements: a comprehensive project analysis determines the specific requirements of the end-product and should include an in-depth study of the users, the intended delivery systems and the scope of the project. These should be documented so that developers and clients can refer to them in order to ascertain whether the product is meeting the required standards.

Design Specifications: the design specifications provide a detailed description of the program requirements to all members of the development team. It incorporates essential information such as the font sizes to be used, colour palettes, file formats and flowcharts that outline the proposed content.

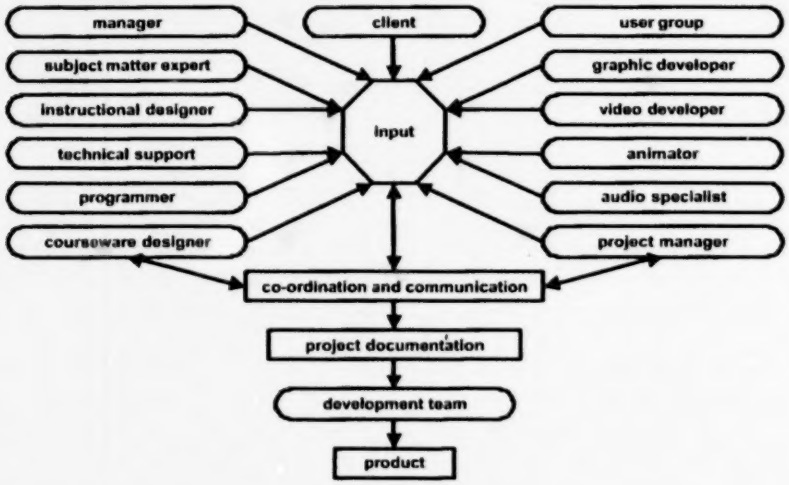

Figure 2: Structure of a Typical Multimedia Development Team

Human-Computer Interface (HCI) Issues: the end-user interface encompasses a number of factors including the proposed screen layouts, navigation controls, user interaction, 'look and feel' and the nature of the various metaphors that are embedded within the courseware.

Delivery Medium: multimedia learning products can be delivered in a number of ways. For example, CD-ROM publication, the Internet, an intranet or local area network, and various types of turnkey solution. Each delivery method has constraints and limitations that should be addressed at the planning stage of the project.

Resource Production: multimedia learning products can contain a combination of text, graphics, audio, video and animation. The establishment of appropriate parameters for each of these at the outset of the project avoids inconsistencies within the final product.

Program Integration: the ease with which multimedia elements are integrated depends critically upon the availability of a comprehensive script and detailed flowcharts to assist the programmers and resource producers. A good file naming strategy is also essential to the integration of resource files.

Quality Control and Evaluation: both formative and summative evaluation strategies need to be identified during the planning stage and quality control should be regarded as a continuous process. A thorough testing strategy should be established that allows all errors to be noted and amended effectively. Ongoing testing and evaluation should be employed throughout Phases 1, 2 and 3 in order to ensure that the final product falls within a pre-specified 'region of acceptability'. As we discuss later, *'ongoing evaluation'* is an important aspect of the dissemination phase of the methodology.

Documentation: good documentation is essential to ensure that any project life cycle evolves efficiently and within the allotted time. The basic documentation required for most multimedia projects comprises: a project proposal; design specifications; scripts and storyboards; quality control and testing strategies; and progress reports

Scripts and Storyboards: scripts are paper-based documents that provide a detailed description of the courseware content and howthis is to be implemented within the final product. Scripts contain details of all on-screen text, audio transcripts, written descriptions of graphics, video and animation along with their file names. These form the basis of audio scripts, graphics listings and video and animation storyboards. Scripts also provide special instructions and detailed flowcharts for the programming team.

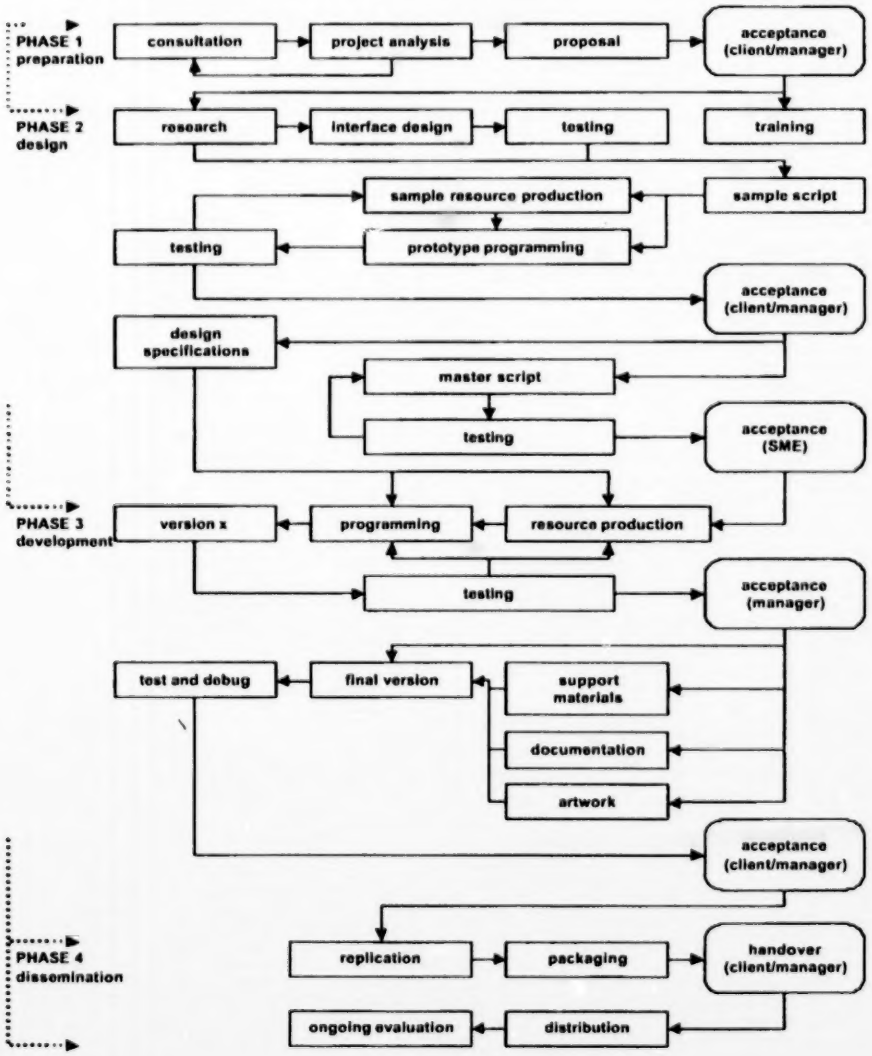

Figure 3: Development Methodology for Interactive Multimedia Courseware

Dissemination: the dissemination phase of product development involves all the processes necessary to package the product and make it available to customers. Of course, even after a learning product has been

released for distribution (see Phase 4 in Figure 3) it is important to undertake a programme of *'ongoing evaluation'*. The results of this type of evaluative study can subsequently be used to fine-tune future releases of the learning product and also inform the design and development processes involved in the creation of new courseware products.

Discussion

One of the most convincing arguments for the use of models stems from the fact that they enable us to make accurate predictions about the properties and behaviour of the systems that they describe. In this paper we have described a methodology to facilitate the development of interactive multimedia learning products. The methodology that was outlined in the previous section has been derived primarily from our experiences with conventional multimedia learning products involving the creation of interactive CDs. It is therefore necessary to discuss whether or not the methodology (as presented in Figure 3) could be applied to the development of other types of interactive learning product - particularly those involving the use of an intranet or the World Wide Web. Our experiences to date suggest that the basic methodology (with some minor amendments) would easily handle this latter type of product. Essentially, Phases 1 through 3 could be used as they stand. So far, we have found that the only area where minor amendments may be needed is in Phase 4. In this phase, the 'replication' and 'packaging' steps may be less important for an intranet/Internet project than they would be for a CD project. We are therefore optimistic that the proposed methodology can be used to cater for a wide range of interactive multimedia learning product development projects

Conclusion

Developing interactive multimedia courseware products is a complex and costly process that requires a wide range of powerful models and a workable, practical design and development methodology. In this context, a structured design and development approach has a number of advantages. For example, templates and scripts provide essential information in easy-to-read formats that can be tailored to meet the requirements of individual team members. In addition, the production process can be made simpler and more efficient - as fewer program and resource changes are required at the development stage. Furthermore, quality control is made more effective by providing testers and evaluators with a program 'blueprint'.

A learning product development methodology, such as the one that has been described in this paper, should enable multimedia courseware products to be developed in a more predictable way - both in terms of learning outcomes and from the perspective of resource utilisation (time and money). Implicit in the various project phases that we have described in our methodology are a number of local and global interactions - both between the underlying models and the system variables that are involved in managing the preparation, design, development and dissemination processes. It is through a greater understanding of these interactions that we will be able to gain further, much needed, insight into the various factors that are responsible for causing multimedia learning projects to fail.

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